


FORM PTO 1390 (REV 3-93)		US DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY DOCKET NUMBER 2001_1199A
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. §371			U.S. APPLICATION NO. (if known, 35 U.S.C. §371(c)(3)) NEW <b>09/914923</b>
International Application No. PCT/NO00/00083	International Filing Date March 8, 2000	Priority Date Claimed March 10, 1999	
Title of Invention A FRICTION MEMBER AND A METHOD FOR ITS SURFACE TREATMENT			
Applicant(s) For DO/EO/US Torkil STORSTEIN; Claes KUYLENSTIERNA; and Jouko KALMI			
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:			
1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. §371. 2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. §371. 3. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. §371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. §371(b) and PCT Articles 22 and 39(1). 4. <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date. 5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. §371(c)(2)) a. <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau). b. <input checked="" type="checkbox"/> has been transmitted by the International Bureau. <b>Attachment "A"</b> c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US) 6. <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. §371(c)(2)). <b>Attachment "B"</b> 7. <input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. §371(c)(3)). a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau). b. <input type="checkbox"/> have been transmitted by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input type="checkbox"/> have not been made and will not be made. 8. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19. 9. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. §371(c)(4)). 10. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. §371(c)(5)). Items 11. to 14. below concern other document(s) or information included: 11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. <b>Attachment "D"</b> 12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. 13. <input type="checkbox"/> A FIRST preliminary amendment. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment. 14. <input checked="" type="checkbox"/> Other items or information: <u>Unexecuted</u> Declaration and Power of Attorney along with cover letter - <b>Attachment "C"</b> International Preliminary Examination Report - <b>Attachment "E"</b>			

U.S. APPLICATION NO. <b>09/914923</b> NEW		INTERNATIONAL APPLICATION NO. PCT/NO00/00083		ATTORNEY'S DOCKET NO. 2001 1199A					
15. <input checked="" type="checkbox"/> The following fees are submitted  <b>BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)):</b> Neither international preliminary examination fee nor international search fee paid to USPTO and International Search Report not prepared by the EPO or JPO ..... \$1000.00 International Search Report has been prepared by the EPO or JPO ..... \$ 860.00 International preliminary examination fee not paid at USPTO but international search paid to USPTO ..... \$ 710.00 International preliminary examination fee paid to USPTO but claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$ 690.00 International preliminary examination fee paid at USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) ..... \$ 100.00  <b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>				<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 50%;">CALCULATIONS</th> <th style="width: 50%;">PTO USE ONLY</th> </tr> <tr> <td style="height: 100px; vertical-align: bottom;">\$1,000.00</td> <td></td> </tr> </table>		CALCULATIONS	PTO USE ONLY	\$1,000.00	
CALCULATIONS	PTO USE ONLY								
\$1,000.00									
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$					
Claims	Number Filed	Number Extra	Rate						
Total Claims	8 -20 =	-0-	X \$18.00	\$					
Independent Claims	2 - 3 =	-0-	X \$80.00	\$					
Multiple dependent claim(s) (if applicable)			+ \$270.00	\$					
<b>TOTAL OF ABOVE CALCULATIONS =</b>				\$1,000.00					
<input type="checkbox"/> Small Entity Status is hereby asserted. Above fees are reduced by 1/2.				\$					
<b>SUBTOTAL =</b>				\$1,000.00					
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				+	\$				
<b>TOTAL NATIONAL FEE =</b>				\$1,000.00					
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40 per property				+	\$				
<b>TOTAL FEES ENCLOSED =</b>				\$1,000.00					
				Amount to be refunded	\$				
				Amount to be charged	\$				
a. <input checked="" type="checkbox"/> A check in the amount of \$1,000.00 to cover the above fees is enclosed. A duplicate copy of this form is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. 23-0975 in the amount of \$_____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 23-0975.									
<b>NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or          (b)) must be filed and granted to restore the application to pending status.</b>									
19. CORRESPONDENCE ADDRESS   <div style="text-align: center;">   <b>000513</b>          PATENT TRADEMARK OFFICE       </div>			By: <u>Michael S. Huppert</u> Michael S. Huppert, Registration No. 40,268  WENDEROTH, LIND & PONACK, L.L.P. 2033 "K" Street, N.W., Suite 800 Washington, D.C. 20006-1021 Phone: (202) 721-8200 Fax: (202) 721-8250  September 6, 2001						

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## A FRICTION MEMBER AND A METHOD FOR ITS SURFACE TREATMENT

The present invention relates to a method for surface treatment of friction members like brake discs, drums, clutch parts and more particularly to treatment of PMMC based members and further to thereby provided friction members.

Conventional brake discs are presently made of ferrous alloys/cast iron having satisfactory performance and maintaining operative even at substantially elevated temperatures up to above 700°C.

However, the present tendency in the automotive industry to reduce the total weight of vehicles challenges new lighter materials to penetrate also this particular segment of vehicle construction. Furthermore, improved corrosion resistance, as well as wear resistance increasing the lifetime of the friction members up to the expected life period of the vehicles, is also a task when looking for replacement of the present ferrous materials.

Consequently, several patent applications have been filed world-wide recently disclosing use of PMMC (Particle Metal Matrix Composite, e.g. Al-alloy matrix reinforced by ceramic particles) based components applied for different actual applications in vehicles. Shortcomings in common for all these applications based on PMMC base material are the softening phenomena at elevated temperatures, something which results in scoring and even plastic deformation of the members' surface, thus considerably limiting the maximum allowed operating temperatures of the members. Therefore, as a remedy, it is instrumental to provide the basis PMMC-made friction members either with a special composite/-ceramic coating layer (thermal spraying of ceramics), or with a transfer surface layer.

The provision of an alternative transfer layer requires the layer to be both stable (adherent to the substrate and reliable) and homogeneous. Furthermore, fast formation of the layer having a sufficient thickness is also requested both from a manufacturing, cost and performance point of view.

One feasible way to cope with the task of increasing the maximum operating temperature is simply to increase the volume percentage of reinforcing particles. Unfortunately, two major disadvantages connected to this "solution", namely increased costs of the PMMC base material and difficulties related to production/casting and especially cutting/-machining of the surface, eliminate this as a possibility for a cost efficient manufacturing method.

It is therefore an object of the present invention to provide a novel, fast and cost efficient method of manufacturing friction members avoiding the above mentioned drawbacks and difficulties connected to the hitherto known methods and products.

Another object of the present invention is to provide a fast developing and homogeneous transfer layer exhibiting more stable friction properties, especially at high operating temperatures.

Still another object of the present invention is to provide better protection for the base matrix material against scoring.

These and other objects and features of the present invention are met by provision of a novel manufacturing method of friction members as apparent from claim 1 and the resulting friction member in claim 7, respectively.

The invention will now be described in detail in the following by way of examples of preferred embodiments of the manufacturing method and the resulting members referring to Figures 1-4, where

- Fig. 1 shows in a perspective view a typical disc brake system,
- Fig. 2 illustrates schematically in principle the novel surface topography of the friction member treated in accordance with the present invention,
- Fig. 3 shows a microscope image of an untreated surface, and
- Fig. 4 shows the same surface after exposure to an etching agent as described in the following under Examples.

Referring to Figs. 1 and 2, Fig. 1 shows a disc brake system where the brake disc 1 is the rotating part which together with the friction linings 15 held in place by the caliper 13 creates the friction.

The novel surface treatment according to the invention is applied to the friction surfaces 12 of the disc.

Fig. 2 illustrates schematically a detailed view of the surface of the member (disc) 12 treated in accordance with the present invention.

Contrary to the present practice and trend to add a special surface layer, e.g. in the form of a composite or sprayed ceramic layer, the gist of the present novel treatment method lies in a selective partial removal of the base matrix material from the active to be frictional surface(s) of the member.

The Figure shows in a cross sectional view the (top) surface 2 of the member 1, where the original top layer depicted as 23 has been removed according to the present invention most advantageously by means of chemical etching. This treatment results in a novel surface topography exhibiting a surface with reinforcing (ceramic) particles 22 protruding from the matrix 21, later during the initial break-in activating of the brake system becoming an

integrated part of the transfer layer created through initial wear and material transfer from the lining (pad) material. The resulting increased reinforcement of the transfer layer will provide better protection of the matrix alloy from temperature and shear forces.

Tests conducted on samples of PMMC discs surface treated in accordance with the method confirm formation of a fast developing adherent and homogenous transfer layer exhibiting substantially improved performance characteristics of the treated member.

Furthermore, tests have shown that etching increases the pad wear during the initial use of the disc during the creation of the transfer layer. The degree of etching should therefore be chosen to reach an acceptable initial pad wear. After creation of the transfer layer the actual pad wear falls to a lower level.

### **Examples**

Samples of brake discs made of two different AlSiMg matrix alloys reinforced by SiC particles in an amount of 10 to 30 vol% having a size in a range from 5-30  $\mu$  have been subjected to chemical etching applying a solution of NaOH in concentrations from 5-30% up to 20 minutes.

Comparison to the reference samples based on the measurement of surface roughness, friction and performance at elevated temperatures shows improved characteristics on all measured parameters.

A relatively short etching time proved to be adequate to remove a sufficient amount of the aluminium matrix making the SiC particles to protrude from the surface of the brake disc as illustrated by the attached Figs. 3 and 4 showing sample surfaces before and after the etching treatment according to the present invention, respectively.

The actually applied disc samples were made of AlSiMg alloy added 20 weight% of SiC particles.

The surfaces 2 of the samples 1 were exposed for a period of 2 minutes to 12 weight% water solution of NaOH. (Posting 3 depicts an Al-foil applied on the samples as protection of the surfaces prior to microscopic evaluation of the achieved results).

As clearly manifested in Fig. 4, an exposure time of 2 minutes was sufficient to provide an etched surface 2 with SiC particles 4 protruding from the surface 2.

Generally, an etching time from 1-3 minutes and applying 12.5 weight% NaOH solution at room temperature is apparently sufficient to achieve an adequate degree of etching of the surface. Prolonged etching (in excess of 5 minutes) can result in loosening of SiC particles. The temperature and the control of the flow of the etching agent is decisive for the choice of optimal etching time.

The present invention is not limited to the above described examples of the preferred mode of the surface treatment. Thus also other (similar) methods of surface treatment, e.g. electrochemical pickling or chemical etching by means of an appropriate acid, could be applied without departing from the spirit and scope of the present invention. Thus other alkali-based etching agents than the exemplified NaOH, e.g. KOH, could be applied. Also other types of PMMC material applying other reinforcing particles like  $\text{Al}_2\text{O}_3$  instead of the above described SiC-reinforced Al-matrix are the most actual alternatives.

Claims

1. Method of surface treatment of friction members, particularly brake discs/drums or clutch plates in vehicles comprising steps of
  - providing friction members made of PMMC material by any conventional method known per se,
  - in situ formation of a transfer layer on the active surface of the member by removing to a predetermined extent the top layer of the matrix material hereby exposing the surface of the embedded reinforcing particles to a degree providing a transfer layer with increased thickness and stability.
2. Method according to claim 1,  
characterized in that  
the in situ formation of the transfer layer is conducted by means of chemical etching of the PMMC material.
3. Method according to claim 2,  
characterized in that  
sodium hydroxide (NaOH) in concentrations from 5 to 30% is applied as the etching agent.
4. Method according to claim 2,  
characterized in that  
acid reagent is applied as the etching agent.
5. Method according to claim 2,  
characterized in that  
KOH is applied as the etching agent.



6. Method according to claim 1,  
c h a r a c t e r i z e d i n t h a t  
the in situ formation of the transfer layer is done by electrochemical pickling of the PMMC material.
7. Friction member, particularly a brake disc/rotor in an automotive vehicle,  
c h a r a c t e r i z e d i n t h a t  
the member comprising a PMMC body of Al-alloy reinforced by ceramic particles is provided with a surface topography characterized by surface protruding reinforcing particles, said particles becoming an integrated part of the transfer layer.
8. Member according to claim 7,  
c h a r a c t e r i z e d i n t h a t  
the Al-alloy is an AlSi alloy reinforced by SiC particles.

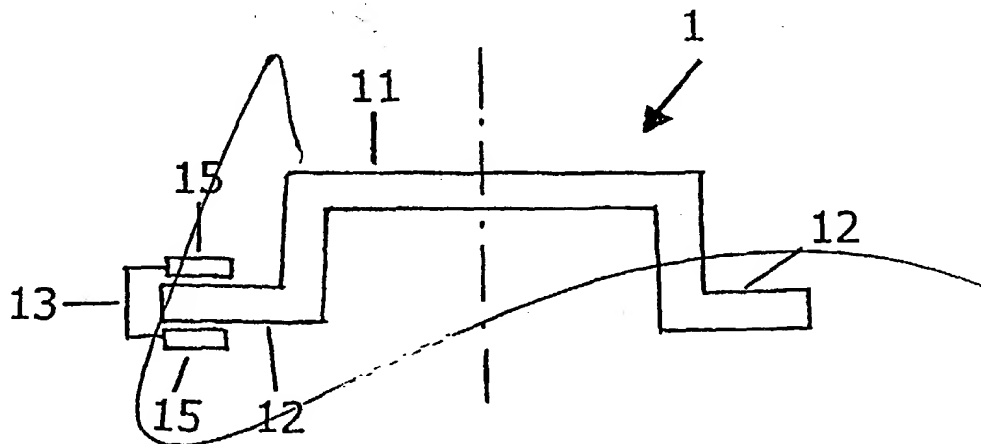
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : <b>F16D 69/02, C23C 12/00</b>		<b>A1</b>	(11) International Publication Number: <b>WO 00/53949</b>
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(21) International Application Number: PCT/NO00/00083 (22) International Filing Date: 8 March 2000 (08.03.00) (30) Priority Data: 19991146 10 March 1999 (10.03.99) NO (71) Applicants (for all designated States except US): NORSK HYDRO ASA [NO/NO]; N-0240 Oslo (NO). VOLVO PERSONVAGNAR AB [SE/SE]; S-405 08 Göteborg (SE). (72) Inventors; and (75) Inventors/Applicants (for US only): STORSTEIN, Torkil [NO/NO]; Holmenveien 93, N-0376 Oslo (NO). KUYLEN-STIERNA, Claes [SE/SE]; Furuhällsvägen 11, S-435 44 Mölnlycke (SE). KALMI, Jouko [SE/SE]; Ångsvägen 6 B, S-541 35 Skövde (SE). (74) Agent: RICANEK, Ivan; Norsk Hydro ASA, N-0240 Oslo (NO).		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.	

(54) Title: A FRICTION MEMBER AND A METHOD FOR ITS SURFACE TREATMENT



## (57) Abstract

Method of surface treatment of friction PMMC members like brake discs is based on in situ formation of a transfer layer by controlled partial removal of the matrix material from the member's surface.

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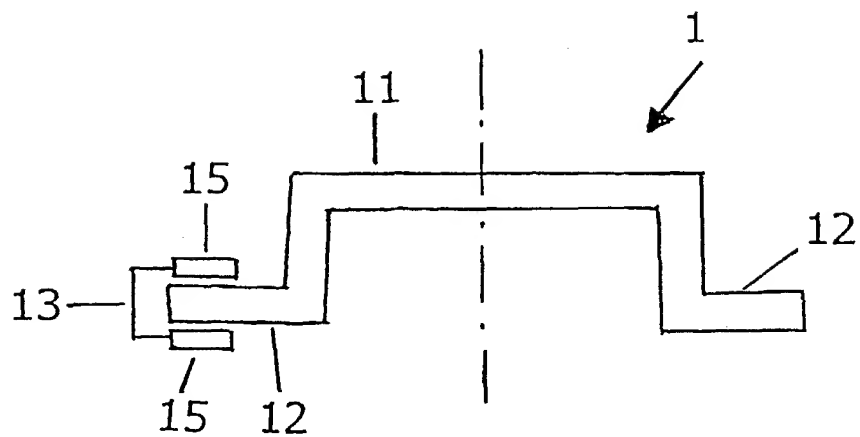


Fig. 1

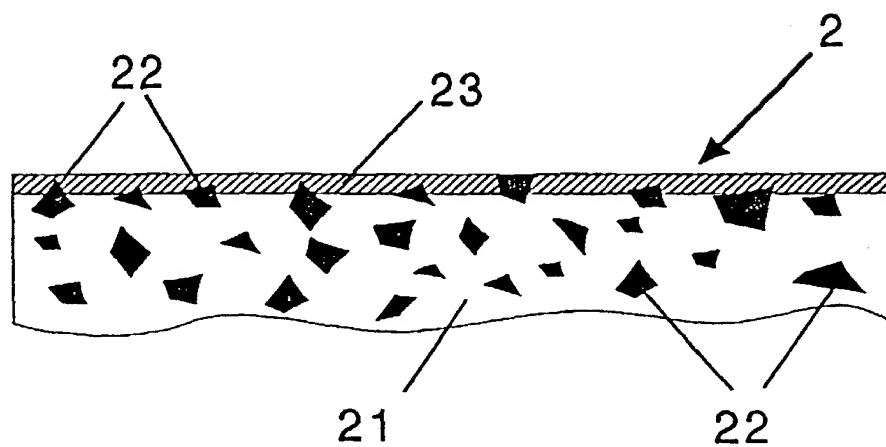


Fig. 2

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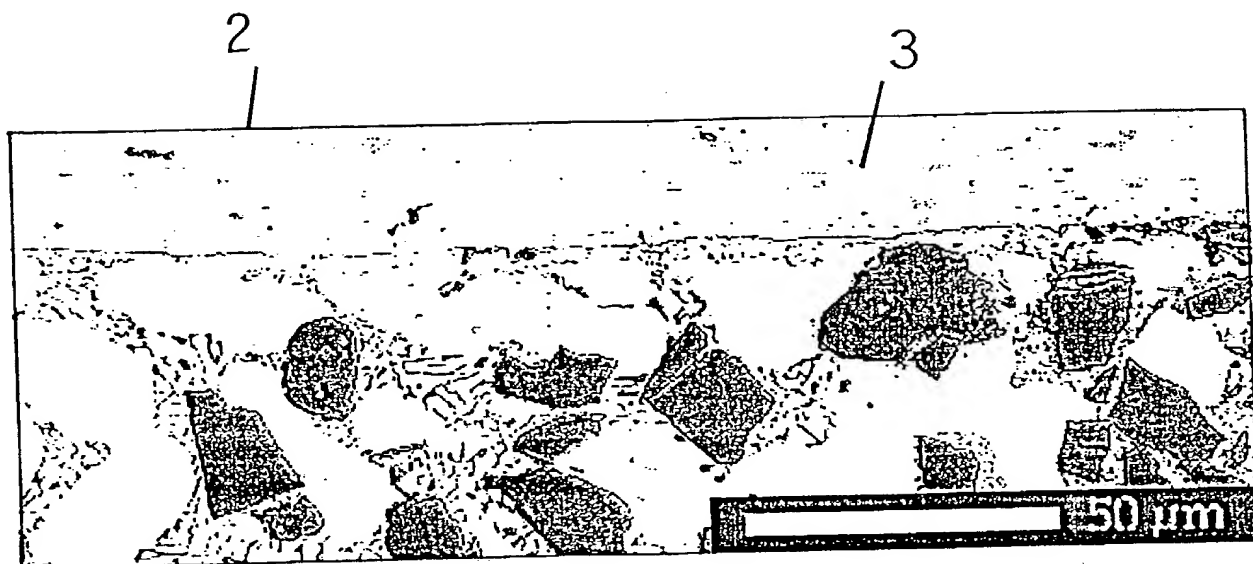


Fig. 3

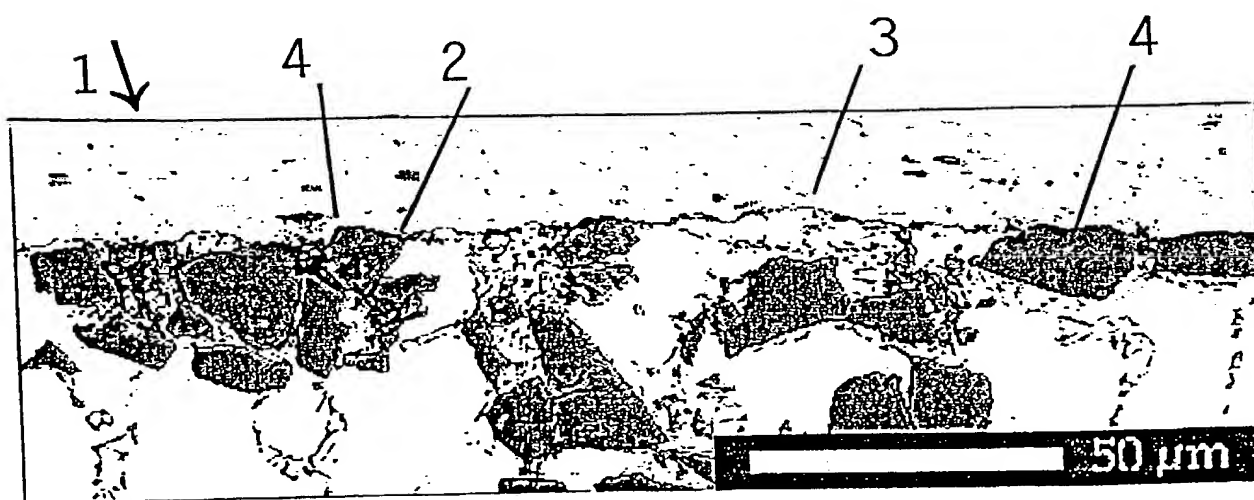


Fig. 4

## DECLARATION AND POWER OF ATTORNEY FOR U.S. PATENT APPLICATION

( ) Original ( ) Supplemental ( ) Substitute ☒ PCT ( ) DESIGN

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Title: A FRICTION MEMBER AND A METHOD FOR ITS SURFACE TREATMENT

of which is described and claimed in:

( ) the attached specification, or

( ) the specification in application Serial No. \_\_\_\_\_, filed \_\_\_\_\_, and with amendments through \_\_\_\_\_, or

(X) the specification in International Application No. PCT/NO00/00083, filed March 8, 2000, and as amended on (if applicable).

I hereby state that I have reviewed and understand the content of the above-identified specification, including the claims, as amended by any amendment(s) referred to above.

I acknowledge my duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim priority benefits under Title 35, United States Code, §119 (and §172 if this application is for a Design) of any application(s) for patent or inventor's certificate listed below and have also identified below any application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

COUNTRY	APPLICATION NO.	DATE OF FILING	PRIORITY CLAIMED
Norway	19991146	March 10, 1999	YES

I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

APPLICATION SERIAL NO.	U.S. FILING DATE	STATUS: PATENTED, PENDING, ABANDONED

And I hereby appoint Michael R. Davis, Reg. No. 25,134; Matthew M. Jacob, Reg. No. 25,154; Warren M. Check, Jr., Reg. No. 33,367; Nils Pedersen, Reg. No. 33,145; Charles R. Watts, Reg. No. 33,142; and Michael S. Huppert, Reg. No. 40,268, who together constitute the firm of WENDEROTH, LIND & PONACK, L.L.P., as well as any other attorneys and agents associated with Customer No. 000513, to prosecute this application and to transact all business in the U.S. Patent and Trademark Office connected therewith.

I hereby authorize the U.S. attorneys and agents named herein to accept and follow instructions from NORSK HYDRO ASA as to any action to be taken in the U.S. Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and myself. In the event of a change in the persons from whom instructions may be taken, the U.S. attorneys named herein will be so notified by me.

Direct Correspondence to Customer No:



000513

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Residence & Citizenship	CITY		STATE OR COUNTRY		COUNTRY OF CITIZENSHIP	
Post Office Address	ADDRESS		CITY		STATE OR COUNTRY ZIP CODE	
Full Name of Sixth Inventor	FAMILY NAME		FIRST GIVEN NAME		SECOND GIVEN NAME	
Residence & Citizenship	CITY		STATE OR COUNTRY		COUNTRY OF CITIZENSHIP	
Post Office Address	ADDRESS		CITY		STATE OR COUNTRY ZIP CODE	

I further declare that all statements made herein of my own knowledge are true, and that all statements on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

1st Inventor	<u>Torkil Storstein</u>	Date	<u>2001-10-26</u>
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	Jouko KALMI		
4th Inventor	_____	Date	_____
5th Inventor	_____	Date	_____
6th Inventor	_____	Date	_____

The above application may be more particularly identified as follows:

U.S. Application Serial No. 09/914,923 Filing Date September 6, 2001

Applicant Reference Number IRI:EMH-P99010 Atty Docket No. 2001\_1199A

Title of Invention A FRICTION MEMBER AND A METHOD FOR ITS SURFACE TREATMENT